2GA3 A1

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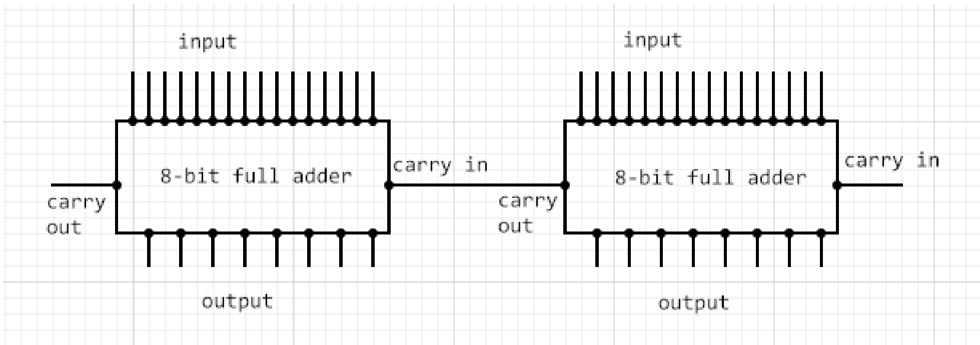
1



a.

As seen in the image above, two 8-bit full adders can be used to add 2 16-bit numbers. The adder on the right takes the first 8 bits of both numbers and outputs the first 8 bits of the result. If the 8th bits being added results in a carry output, that carry-out goes to the carry-in of the second adder. The second adder adds the next 8 bits of both numbers, and outputs the next 8 bits of the result.

b.

A decoder chip takes in n inputs, and based on the input will activate only 1 of its 2^n outputs. A decoder chip can be used in multiplexing/demultiplexing, decoding the output from a counter, and other applications where encoded information must be simplified. If a decoder has 3 input pins, it will have $2^3 = 8$ output pins.

c.

Since the output of a counter increases when the input *transitions* from a 0 to a 1, the input starting at 1 means there was no transition, therefore the output will remain as 000 in the first time step.

input	output	time step
1	000	1
1	000	2
0	000	3
0	000	4
1	001	5
0	001	6
1	010	7
0	010	8
0	010	9
1	011	10

2

a.

k bits can represent 2^k distinct values

basis step

1 bit can represent $2^1 = 2$ values since the bit can either be 0, or 1.

inductive step

assume that k bits can represent 2^k distinct values is true, $k + 1$ bits can represent 2^{k+1} distinct values since you can append a 0 to all values that k bits represent, and also append a 1 to all values that k bits represent resulting in twice the amount of values represented. Since 2^{k+1} is double the value of 2^k and we showed that $k + 1$ bits can represent double the amount of values that k bits can, the proposition holds true.

b.

A 4-bit integer using two's complement can represent a maximum value of 7, and a minimum value of -8. A 4-bit unsigned integer can represent a maximum value of 15, and a minimum value of 0.

3

see file 3.c

4

a.

As we have been instructed to ignore special cases, the largest number that can be represented with an 8-bit float is $1.9375 \times 2^4 = 31$ (sign 0, exponent 111, mantissa 1111).

Assuming smallest refers to the closest number to 0, $1.0 \times 2^{-3} = 0.125$ (sign 0, exponent 000, mantissa 0000) is the smallest number we can represent. Assuming smallest refers to the most negative number, $-1.9375 \times 2^4 - -31$ is the smallest number we can represent.

The smallest increment we can represent is $1.0625 \times 2^{-3} - 1.0 \times 2^{-3} = 0.1328125 - 0.125 = 0.0078125$

b. c.

see file 4.c